SALMONID HABITAT LIMITING FACTORS ANALYSIS

SNOHOMISH RIVER WATERSHED

WATER RESOURCE INVENTORY AREA

7

FINAL REPORT

WASHINGTON STATE
CONSERVATION COMMISSION

Donald Haring
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ACRONYMS AND ABBREVIATIONS USED IN THIS REPORT

The following list provides a guide to acronyms and abbreviations used in this report:

BMP	Best Management Practices
BPA	Bonneville Power Administration
CERCLA	Comprehensive Environmental Remediation and Cleanup Liability Act (typically associated with EPA Superfund sites)
cfs	cubic feet per second (a measure of water flow)
CMZ	Channel Migration Zone
CSO	Combined Sewer Overflow
CW	Channel width
CWA	Clean Water Act
dbh	diameter breast height (measurement of tree diameter)
DNRP	King County Department of Natural Resources and Parks
EF	East Fork
ESA	Endangered Species Act
IFIM	Instream Flow Incremental Methodology
LB	Left Bank (looking downstream)
LWD	Large Woody Debris
m	meter
MF	Middle Fork
mgd	million gallons per day
mg/L	milligrams/Liter
mi	mile
mi^2	square miles
NF	North Fork
NRCS	Natural Resource Conservation Service
NWIFC	Northwest Indian Fisheries Commission
ppm	parts per million
RB	Right Bank (looking downstream)
RM	River Mile
SASSI	Salmon and Steelhead Stock Inventory
SEWIP	Snohomish Estuary Wetland Integration Plan
SF	South Fork
SPTH	Site Potential Tree Height
SSHIAP	Salmon and Steelhead Habitat Inventory Assessment Project
SSI	Salmonid Stock Inventory
SWM	Snohomish County Public Works, Surface Water Management Division
TAG	Technical Advisory Group
TFW	Timber, Fish, and Wildlife
TSS	Total Suspended Solids
USFS	U.S. Forest Service
WAC	Washington Administrative Code (rules implementing state statutes)
WADNR	Washington State Department of Natural Resources
WDFW	Washington State Department of Fish and Wildlife
WF	West Fork
WRIA	Water Resource Inventory Area
WSDOT	Washington State Department of Transportation

WWTIT	Western Washington Treaty Indian Tribes
WWTP	Wastewater Treatment Plant
yd^3	cubic yards
yr	year

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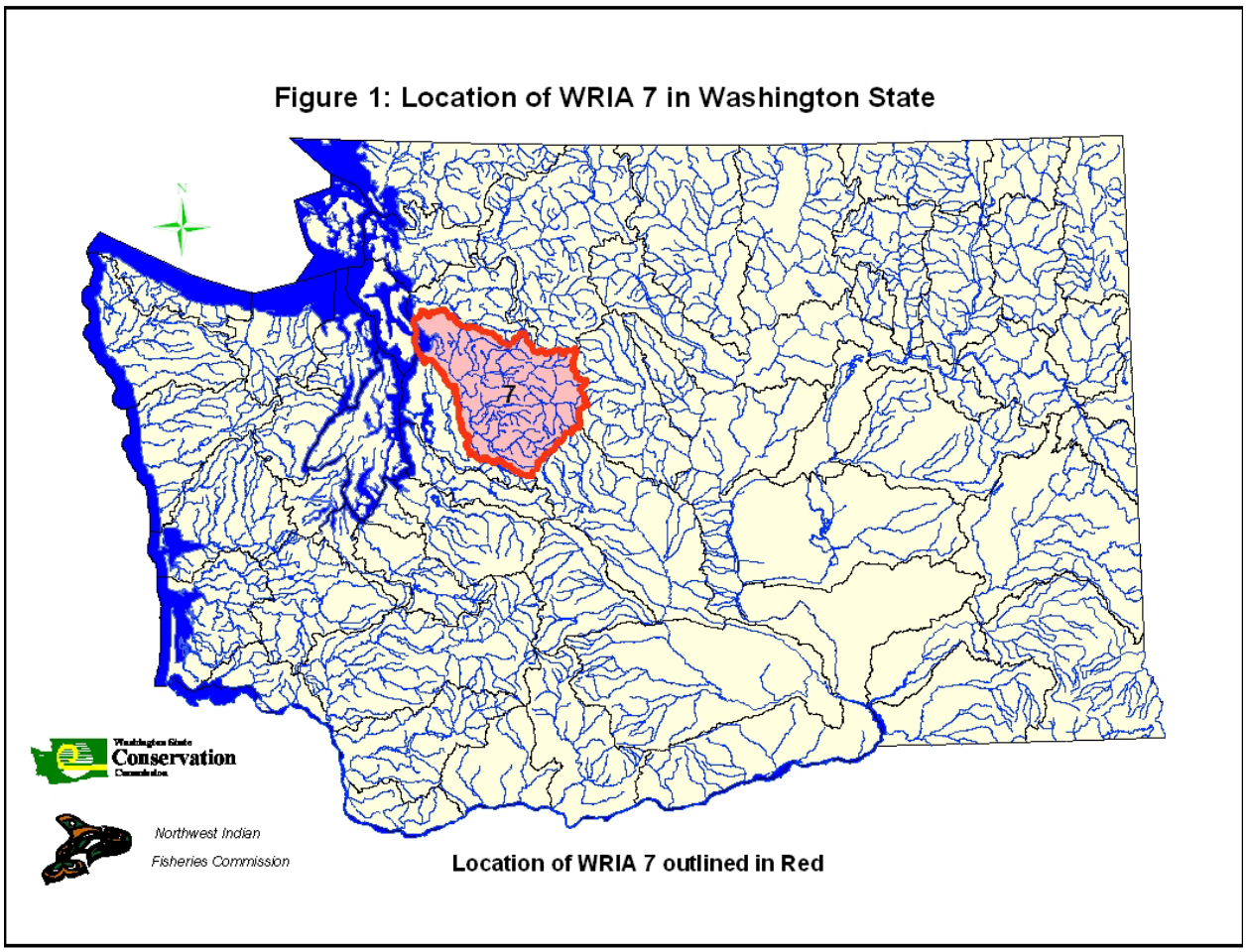
EXECUTIVE SUMMARY

Section 10 of Engrossed Substitute House Bill 2496 (Salmon Recovery Act of 1998), directs the Washington State Conservation Commission, in consultation with local government and treaty tribes to invite private, federal, state, tribal, and local government personnel with appropriate expertise to convene as a Technical Advisory Group (TAG). The purpose of the TAG is to identify limiting factors for salmonids. Limiting factors are defined as "conditions that limit the ability of habitat to fully sustain populations of salmon, including all species of the family Salmonidae." It is important to note that the charge to the Conservation Commission in ESHB 2496 does not constitute a full limiting factors analysis. A full habitat limiting factors analysis would require extensive additional scientific studies for each of the subwatersheds in the Snohomish River watershed (Water Resource Inventory Area (WRIA) 7. Analysis of hatchery, hydro, and harvest impacts would also be inherent components of a comprehensive limiting factors analysis; these elements are not addressed in this report, but will be considered in other forums.

Figure 1: Location of the Snohomish River watershed (WRIA 7) in Washington State



The Snohomish River watershed is the second largest river basin draining to Puget Sound, with a watershed area of 1,980 square miles (Pentec 1999)(Figure 1). Elevations in the watershed range from sea level to 8,000 feet (Gersib et al. 1999). The watershed includes three major rivers, the Skykomish, the Snoqualmie, and the Snohomish, which flow west through broad, glaciated lowland valleys and enter Puget Sound near Everett. These rivers and their tributaries support significant runs of anadromous salmonids, including coho, chinook, chum, and pink salmon, steelhead trout, bull trout/Dolly Varden, and other resident trout species. The Snohomish River watershed, with its multitude of tributary streams, is the second largest watershed in Puget Sound. There are 720 miles of streams in WRIA 7 that are known to support anadromous salmonids and bull trout/Dolly Varden. In addition, WRIA 7 includes ~25 miles of marine shoreline that supports local anadromous salmonid stocks, as well as salmonid stocks from other Puget Sound WRIAs.

The status of identified salmon, steelhead, and bull trout/Dolly Varden stocks in WRIA 7 is shown in Table 1; more detailed information on the stocks can be found in the Distribution and Condition of Salmon, Steelhead, and Bull trout/Dolly Varden chapter. Anadromous salmonids and bull trout/Dolly Varden are known to occupy 720 miles of streams within WRIA 7, with additional areas with presumed presence of these species (Table 2). Known and presumed distribution of anadromous salmonids and bull trout/Dolly Varden are shown on the individual species maps included in the separate Map files included with this report, and supporting data in

Table 1: Snohomish Watershed Salmon, Steelhead, and Bull trout/Dolly Varden Stock Designations and Associated Status

Stock	**Salmonid Stock Inventory Status**	**ESA Listing Status**
Skykomish chinook (includes Snohomish and Pilchuck)	Depressed	Threatened
Snoqualmie chinook	Healthy	Threatened
Skykomish chum	Healthy	Not warranted
Snoqualmie chum	Unknown	Not warranted
Wallace chum	Healthy	Not warranted
Snohomish odd-year pink	Healthy	Not warranted
Snohomish even-year pink	Healthy	Not warranted
Snohomish coho	Healthy	Candidate
Skykomish coho	Healthy	Candidate
SF Skykomish coho	Healthy	Candidate
Snoqualmie coho	Healthy	Candidate
Tolt summer steelhead	Healthy	Not warranted
NF Skykomish summer steelhead	Unknown	Not warranted
SF Skykomish summer steelhead	Healthy	Not warranted
Snohomish/Skykomish winter steelhead	Depressed	Not warranted
Pilchuck winter steelhead	Depressed	Not warranted
Snoqualmie winter steelhead	Depressed	Not warranted
Snohomish bull trout/Dolly Varden	Healthy	Threatened
Snohomish coastal cutthroat	Unknown	

Table 2: WRIA 7 fish distribution extent (miles)			
Species	Known	Presumed	Presumed Floodplain
Chinook	314.1	10.7	253.4
Chum	225.5	38.3	255.8
Pink	248.8	19.1	257.2
Coho	686.6	41.7	183.8
Steelhead	447.4	32	240.4
Bull trout/Dolly Varden	232	500	188.3
All	719.9		

Appendix A. There are additional areas of the watershed with extensive distribution of resident salmonids (e.g., upstream of Snoqualmie Falls, upper Tokul Creek, upper SF Tolt, Sultan River upstream of Culmback Dam, upper Wallace River drainage, upper Woods Creek, etc.), although resident salmonid distribution is not directly considered in this report.

Annual precipitation in WRIA 7 ranges from 35 inches in the lower watershed to 180 inches near the Cascade Mountain crest. A large portion of the Snohomish River watershed drains high-elevation areas of the Cascade Mountains, with spring and early summer snowmelt strongly influencing streamflow patterns in the basin (Pentec 1999). All of the major rivers draining high-elevation lands, including the Skykomish, Snoqualmie, and Snohomish rivers, feature two distinct periods of high monthly flows: high streamflow resulting from winter streamflow occurs in the months of November, December, and January; high monthly flows resulting from high elevation snowmelt occurs during the months of May and June. The mountain snowpack plays a strong role in controlling summer low flow conditions. Annual low flows occur at almost all stream gauges in August, because most of the snowmelt runoff has occurred and very little rainfall typically occurs in July and August. Low-flow basins, such as the Raging River and other small lowland streams, do not benefit from high elevation snowpack. Peak flows in these streams are typically associated with winter storms from October through March, and then decrease to the low point in August (Chamblin).

Data included in this report include formal habitat inventories or studies specifically directed at evaluating fish habitat, other watershed data not specifically associated with fish habitat evaluation, and personal experience and observations of the watershed experts who participated in the TAG. The analysis of habitat conditions in the Snohomish River watershed (WRIA 7) and associated action recommendations are based on these data. Although many of the habitat data/observations in this report may not meet the highest scientific standard of peer reviewed literature, they should nevertheless be considered as valid, as they are based on the collective experience of the watershed experts who are actively working in these drainages. Although there are a significant number of past studies and reports on these watersheds, a large number of salmonid habitat "data gaps" remain, which will require additional specific watershed research or evaluation.

Although some of the historic actions that led to the dramatic decline in salmonid presence in the Snohomish River watershed have ceased or been reduced, and significant restoration efforts have been implemented to address some of these elements, there are numerous habitat-related problems remaining through the watershed that continue to limit salmonid productivity potential. These impacts include:

- Fish Access – Adult and juvenile salmonid access to historic spawning and rearing habitats is significantly impaired in many areas of the watershed by a variety of fish passage barriers (e.g., culverts, dams, dikes/levees, and water quality). Recent inventory

efforts have substantially increased the knowledge base of the extent of fish passage barriers in the watershed. Various entities in the watershed have been aggressively working to correct identified fish passage barriers; however, numerous barriers remain. In addition, dikes and levees preclude or inhibit access to floodplain wetland habitats that could provide excellent rearing. Juvenile and adult salmonids are conveyed with floodwaters into areas behind many of the dikes/levees on an infrequent basis (Snohomish dikes/levees are designed to overtop at a 5-year flood +1 foot), but little resulting production may come from these areas due to low dissolved oxygen levels and other water quality problems that may preclude successful outmigration to the river. Some of the effects of lost salmonid production due to access constraints are masked by the establishment of anadromous access (July-December) beginning in 1958 to the entire SF Skykomish upstream of Sunset Falls. Sunset Falls was historically a natural anadromous barrier; anadromous passage has resulted in known/presumed anadromous salmonid/bull trout/Dolly Varden utilization of 72.9 miles (roughly 10% of the Snohomish basin-wide distribution) of historically inaccessible habitat. However, the intent of providing anadromous passage at Sunset Falls was to provide additional salmonid production, rather than to mitigate for losses elsewhere in the watershed. Correction of identified barriers would restore access to available salmonid habitat.

- Floodplain Modifications – Perhaps one of the most profound impacts to salmonid habitat in WRIA 7 has been the loss or impairment of floodplain function. Much of the historic production capacity is thought to have been associated with the vast presence of floodplain and estuarine wetlands. Bortelson et al. (1980) estimate there has been a 74% reduction in presence of floodplain wetlands, and a 32% loss of intertidal wetlands for the Snohomish River. Settlers drained and/or isolated ~3370 hectares of palustrine marsh in the Snohomish River floodplain upstream of Ebey Slough (Haas and Collins 2001). Diking and bank armoring have also contributed to a 2-kilometer decrease in total length of side channels and a 55% reduction in the area of side channel sloughs on the Snohomish River. There has also been a 40% loss of beaver pond area (not including habitat loss in vast floodplain areas). Extensive historical floodplain wetlands at Marshland and lower French Creek have been diked and drained, and no longer provide salmonid habitat. Estimates of lost chinook and coho production capacity associated with the loss of floodplain habitat are 40-61% and 50%, respectively (Haas and Collins 2001). There are concerns with the methodology and accuracy of these estimates, but there does not appear to be any disagreement that the loss of Snohomish floodplain and estuarine function has severely affected salmonid production capacity. Floodplain function has also been severely impaired or lost further upstream on the mainstem rivers and on tributaries by conversion of historical stream associated wetlands to agriculture, and increasing recent conversion of these areas to commercial/residential development. In addition, floodplain function has been severely impaired by ditching and channelization, particularly in agricultural areas and along roads, to improve drainage of naturally wet areas. The cumulative loss of wetlands in these areas has not been estimated, but is likely very significant. Drainages where floodplain wetland connectivity remains relatively intact (e.g., Griffin Creek, Carpenter Creek, Dubuque/Panther Creek, Little Pilchuck Creek) typically produce significantly larger numbers of coho than drainages where floodplain function has been significantly altered.
- Channel Conditions – The loss of channel complexity, cover, bank stability, and presence of pools has adversely affected spawning and rearing habitat. Channel condition and complexity have been dramatically altered through most of the watershed by channelization, loss of large woody debris (LWD) and associated pools, and by loss of bank stability and complexity due to a variety of land use practices. LWD presence is critical to creating habitat diversity, cover, pools, and collecting and retaining sediment

and gravels. Much of the historical LWD was removed from the Snohomish, Snoqualmie, and lower Skykomish Rivers to improve navigation in the late 1800s-early 1900s. LWD recruitment potential is severely impaired in these areas by presence of dikes and levees. LWD is generally absent from most low floodplain areas of mainstem rivers and tributaries, particularly where the streams have been extensively managed through agricultural areas and along roads; LWD recruitment potential in these areas is poor in most locations due to lack of woody riparian vegetation and active removal of any wood that does fall into the creeks. LWD presence is also poor in streams in forested areas, particularly where there has been active forest management, due to stream cleanout and past harvest of riparian trees. Although current LWD condition may be poor in many of these streams, there is potential for future recruitment potential due to recent changes in federal and non-federal forest management.

- Substrate Conditions – Gravel substrate quality is adversely affected by increased presence of fines (<0.85mm) and loss of suitable spawning gravels, affecting spawning success and benthic productivity. Gravel substrates are impaired in many areas of the watershed by significant presence of fine sediments, typically associated with development, agricultural, and forestry land uses. Typical loss of coarse sediment (gravel) transport associated with dams does not appear to be a current limiting factor at Culmback Dam on the Sultan River; the loss of gravel transport downstream of the dam on the SF Tolt has been compensated to some extent by high landslide activity downstream of the dam (Parametrix 2001), but a coarsening of the substrate in the SF Tolt has been observed since 1992 (Nelson).
- Riparian Conditions – Riparian function is integral to the structural stability, diversity, and water quality elements of fish habitat. Impaired riparian function throughout much of the watershed has resulted in increased water temperature, loss of bank stability, loss of instream cover, and loss of LWD recruitment to streams. Riparian function has been severely impaired throughout much of the basin by removal of riparian vegetation; by construction of dikes/levees, roads, etc. that preclude riparian vegetation growth; by channel incision, and channelization that lower the water table in riparian areas; and by altered hydrology that affects the stability and integrity of streambanks. Because of the importance of riparian function to salmonid habitat, it is of critical importance to initiate protection/restoration of riparian function, as some of the key riparian attributes (e.g., LWD recruitment) may not be realized for 80-120 years.
- Water Quality – Salmonids require cool, clean water for effective spawning and rearing. Increased water temperatures in the mainstem and many tributaries affect habitat suitability for spawning and rearing, and also increase suitability for predator species that are known to prey on juvenile salmonids. High water temperatures are identified as a concern in mainstem and tributary areas, typically associated with impaired riparian function. Past limiting factor concerns of low dissolved oxygen levels in the estuary, associated with wood processing mill waste disposal, were corrected in 1975 and are no longer considered as a key problem. However, low dissolved oxygen may be adversely affecting salmonid survival in some estuarine sloughs and tributaries elsewhere in the watershed, particularly upstream of drainage district pump plants (e.g., lower French Creek, Marshland, Swan Trail Slough, etc.) and in areas with high nutrient input (often associated with unrestricted livestock access).
- Water Quantity – Salmonids require suitable instream flows at specific times of the year for effective spawning, incubation, and rearing. The key identified concerns related to water quantity in WRIA 7 are instream water withdrawals, altered hydrology associated with increased impervious surfaces, and altered hydrology from increased rain-on-snow runoff. Several subwatersheds are identified as potentially being at increased

susceptibility to effects from groundwater withdrawals, particularly in areas that are experiencing increased commercial/residential development, although there was insufficient information to determine the extent of impacts. The major water withdrawals in the watershed are the City of Snohomish withdrawal from the Pilchuck River, the City of Everett withdrawals from the upper end of Ebey Slough and the Sultan River, and the Seattle City Light withdrawal from the SF Tolt River. Flow modeling estimates that modification of the seasonal withdrawal pattern associated with the water right transfer would generate negligible physical change in the river flow characteristics of the estuary (Metzgar). The Tulalip Tribes are concerned that the impacts of the withdrawal on Ebey Slough have not been adequately assessed (Nelson), and have appealed the issuance of the water right change (hearing scheduled December 20, 2002 in Thurston County Superior Court). Mitigation associated with the withdrawals on the Sultan and SF Tolt has resulted in reduced peak flows and increased low summer flows downstream of the dams; any outstanding concerns related to instream flows in the Culmback Dam to diversion dam reach on the Sultan River can be considered through the FERC relicensing discussions. The Pilchuck River withdrawal is of concern as it reduces summer low flows downstream of the diversion dam, although effects to salmonid production have not been assessed; there are also fish passage concerns associated with the dam. Natural hydrology has been altered in several of the watersheds within WRIA 7 (e.g., Quilceda and Allen Creek watersheds), the result of increased impervious surfaces from development that result in increased stormwater runoff. The increased frequency and magnitude of peak flows affects streambank and channel habitat integrity. The associated reduction in infiltration of stormwater and loss of wetland function result in a significant reduction in summer base flows, adversely affecting those species that reside in freshwater for an extended period prior to outmigration. Development regulations need to ensure that the natural hydrologic regime is maintained. Adverse impacts have also been identified for several streams (e.g., Beckler River) in the upper forested portions of WRIA 7, where forest harvest has resulted in increased runoff during rain-on-snow events. Most of the hydrologic analyses to date have been unable to detect significant changes associated with timber harvest in the rain-on-snow zone, but there seems to be consensus recognition that adverse effects have occurred. Forest harvest reductions, particularly on Forest Service Lands, should reduce any rain-on-snow associated impacts over time.

- Lakes – There is one large natural lake (Lake Stevens) and hundreds of small lakes in WRIA 7. The primary salmonid habitat concerns associated with lakes in WRIA 7 are the extent of shoreline hardening and number of overwater structures, and lake level management control that affects flows downstream of the lake. Although shoreline hardening and number of overwater structures are identified as concerns in many lakes (e.g., Lake Stevens, Panther/Flowing/Storm lakes), the extent of effects to salmonid production have not been assessed. Similarly, lake level control in some lakes (e.g., Bosworth Lake, instream pond on Purdy Creek) may adversely affect summer baseflows downstream of the lake/pond, but extent of effects to salmonid production have not been assessed.
- Biological Processes –The return of marine-derived nutrients (particularly nitrogen and phosphorous) from salmon carcasses provides an important nutrient source to the oligotrophic waters and riparian areas in the higher elevations of the watershed. WRIA 7 is fortunate to have healthy returns of anadromous salmonid spawners, particularly coho salmon. However the ability to retain marine-derived nutrients in the headwater reaches of the subwatersheds in WRIA 7 may be compromised by the limited presence of LWD and pools in many streams, potentially resulting in carcasses being washed out of the headwater areas. This concern can be addressed by restoring bank and instream habitat

diversity and complexity. Another concern that affects salmonid production, particularly in those subwatersheds that have associated wetland rearing habitat on the Snohomish/Snoqualmie River floodplain, is the presence of invasive fish species in many of these sloughs and wetlands. These invasive species (e.g., bass) are voracious predators, and may be causing significant mortality on rearing juvenile salmonids and outmigrating smolts. No effective control solutions are identified at this time. Even if control/elimination of invasive species were possible in any specific area, the area would likely repopulate as a result of frequent valley-wide floods.

Despite the extensive impacts that have occurred to fresh and marine water habitats in WRIA 7, and the large number of fair, poor, or data gap habitat ratings that exist throughout the area, there are a number of reasons to be optimistic regarding the future of salmonid habitat and productivity in WRIA 7. The Snohomish River watershed (WRIA 7) remains as one of the primary producers of anadromous salmonids and bull trout/ Dolly Varden in the Puget Sound region. However, it is clear that current salmonid habitat conditions, and associated salmonid productivity, could be significantly improved throughout the watershed. Historic salmonid production is estimated to have been substantially greater than that experienced in recent history. The opportunities for habitat protection and restoration in WRIA 7 are greater than in the more developed Puget Sound watersheds to the south. Many of the watersheds are in agricultural or forest management areas, and are not yet locked in place by commercial and residential development. These areas typically offer the greatest habitat protection/restoration potential. However, habitat restoration in other smaller streams should also be actively considered, as they contribute to the overall productivity of WRIA 7, and cumulatively contribute significant overall salmonid production. Several of the more urbanized streams in WRIA 7 have significant salmonid habitat potential, as they are either located in wooded ravines, or have been developed with setbacks that maintain habitat function. Restoration of estuarine and nearshore habitat is also critical, as these habitats are actively utilized by all salmonid species and stocks originating in WRIA 7, as well as stocks originating from other Puget Sound WRIAs. Given the development pressures being experienced in the watershed, the risks to salmonid habitat are great, and it is critical that land use regulations be developed and implemented in a manner that maintains the integrity of salmonid habitat. Increased anadromous salmonid and bull trout/Dolly Varden populations in recent years offer a snapshot of the potential benefits from salmon recovery efforts to date, and should provide incentive to increase habitat protection and restoration efforts throughout the watershed. There is extensive salmonid habitat restoration potential and opportunity remaining. Information in this report can assist in identifying, prioritizing, and implementing salmonid habitat restoration efforts in WRIA 7.

Prioritized habitat action recommendations are provided for each stream in which salmonid presence has been identified, following the discussion of identified salmonid habitat concerns. Those action recommendations at the top of the list are considered to provide greater restoration benefit potential than those towards the bottom of the list, or those on the top of the list may need to be done first to better ensure the effectiveness of those further down the list. The TAG did not prioritize or rank between watersheds on the basis of salmonid productivity potential resulting from habitat restoration. There is general support for the tenets of 1) protect the best remaining habitat, 2) restore those habitat areas that are still functioning, and 3) restore severely impaired non-functioning habitat where feasible. However, strict adherence to these tenets may preclude consideration of high benefit restoration projects in certain watersheds. Habitat restoration projects should be reviewed on their own merits, and the projects prioritized/ranked on the basis of their anticipated benefit to protecting/restoring salmonid production. Habitat protection/ restoration project proposal ranking should consider whether the project addresses the cause of an identified habitat limiting factor, where the project type ranks in the prioritized action

recommendations list for that stream, how the project complements other protection/restoration actions, and how the project complements identified habitats needing protection. Project ranking should also consider projects where willing landowners and partnerships can increase the effectiveness/efficiency of the restoration project. Habitat conditions vary between different reaches of a stream; restoration proposals should consider the potential benefits of the proposal in relation to habitat conditions likely to be encountered elsewhere in the watershed.

Protection/restoration of salmonid resources cannot be accomplished by watershed habitat restoration projects alone. It is unlikely that we will be able to resolve the salmon predicament using the same land management approaches that got us into it. We will need to look at the watershed with a clear new vision. Salmonid recovery will require a combination of efforts, including:

- land use regulations alone will not be effective; habitat restoration and resource protection will also require landowner commitment, participation, and stewardship
- revision, implementation, and enforcement of land use ordinances that provide protection for natural ecological processes in the instream, and riparian corridors
- protection of instream and riparian habitat that is currently functioning, particularly key habitat areas, and
- restoration of natural instream and riparian ecological processes where they have been impaired.

This report provides information that can and should be used in the development of salmonid habitat protection and restoration strategies. It should be considered a living document, with additional habitat assessment data and habitat restoration successes incorporated as information becomes available.